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CONTENTS.

ON INSECTS

BY

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Part V.

(*Continued from Vol. V, 1915, p. 89*).

The last of these articles dealt in a general way with the large order of insects known to entomologists as the *Hymenoptera*, and a key to the two sub-orders and the three series of the second sub-order, was there given.* We shall now proceed to consider the various families into which these sub-orders are divided in more detail.

The adult forms of the insects belonging to the two sub-orders are readily distinguishable one from the other, as members of the first sub-order have no "waist," there being a broad connection between the abdomen and the thorax, while members of the second order have the junction, between the thorax and abdomen reduced to a narrow stalk. Hence the terms *Sessilicentres* (Latin *sessilis*, that stands firmly, and *center*, the belly), and *Petiolata* (Latin *petiolus*, a little stalk) given to the two sub-orders.

The *Sessilicentres* combine three families, the *Cephidae*, *Siricidae*, and *Tenthredinidae*. The first family is unimportant, but the second family contains the insects known as Wood-wasps, and the third family contains the Saw-flies. None of the members of these families have been found to attack tea, but as the members of the last two families are of considerable interest a short account of them will be given here.

The Wood-wasps are essentially forest insects, and the larvae or grubs live in the wood of dead or sickly trees. Pine, spruce, fir, and larch are especially liable to the attacks of these insects, and

* pp. 87-89.

one species does a good deal of damage to spruce trees in the Himalayas, while another species has been found to attack sandal-wood in the Coimbatore Hills in Madras. The adults are large insects, having a general wasp or hornet-like appearance, save that there is no "waist." They are very brightly coloured, and the female is provided with an elongate, cylindrical boring instrument at the extremity of the abdomen. With this instrument she drills holes in the wood, in which she deposits her eggs. These hatch into whitish or yellowish grubs, which are soft, but have an armoured head armed with strong jaws, and excavate winding galleries in the wood in all directions, but generally lengthways. Opinions differ as to the length of time spent in the larval state, some observers putting it at two months, others at more than a year. However this may be, a considerable time elapses before the adult insect emerges, for they often come out of props used in coal mines, and one case is on record of the insects having emerged, in a house in England, from the wood of which it was built, several years after its erection. The larva changes into a pupa in the wood, and the adult insect gains access to the exterior, in some cases by retracing its path through the larval gallery, and in other cases by boring a straight tunnel through the wood to the exterior. Cases have been known in which the insects have emerged from wood encased in lead, gnawing their way through the wood, and finally through the metal.

The Sawflies are of considerable economic importance, as their larvae are often very destructive to forest and fruit trees, vegetables, etc. The adult bears a very similar resemblance to a small bee, except that there is no "waist." The extremity of the abdomen of the female is provided with a pair of saw-like processes, and with these she makes a slit in a leaf or stem, in which she deposits her eggs. These eggs seem to depend, for their development, on the absorption of moisture from the leaf, for if the leaf containing the eggs be severed from the bush the latter fail to develop.* The egg gives rise to an active, caterpillar-like

* Some leaves containing what were possibly eggs of a sawfly were received from a garden in Assam in the early part of last season, but as they failed to develop it was not possible to tell. No sawfly larva has yet been recorded from tea in North-East India.

larva, which, however, can be easily distinguished from a caterpillar by the fact that it is provided with more than eight pairs of legs, whereas caterpillars have, at most, eight pairs. The larva eats holes in and pieces out of the leaf in a manner very similar to caterpillars. When the larva is full grown it descends to the ground, and there forms a pupa or chrysalis, which is enclosed in a silken cocoon. The adult insect, on emerging from the pupa, crawls to the surface of the ground, and hovers round the place from which it has emerged. It is usually sluggish, and does not fly far, and it therefore often happens that a small area may be seriously attacked by sawfly larvae, while surrounding areas are free. An interesting case of maternal solicitude has been observed in the case of a Tasmanian sawfly which attacks *Eucalyptus*. The female watches over the place where the eggs have been laid until the young hatch. She then places herself over the young larvae, protecting them from the heat of the sun and from the attacks of enemies, and continues to do so until she dies.

The sub-order *Petiolata* is divided into three series, and contains the greater portion of the families of the *Hymenoptera*.

The first series, the *Parasitica*, so-called on account of their parasitic habits, comprises eleven families, and contains insects of the greatest economic importance. Some forms, *e.g.*, the gall-wasps (so-called gall-flies) are parasitic on plants, and are responsible for the abnormal growths on plants known as galls, of which common oak-apple of England may be cited as an example. Other forms, *e.g.*, the ichneumons, are parasitic on other insects, and many of them are of great economic importance owing to the controlling influence they exert on insect pests of crops, and on beneficial insects. Too little is known of these forms. For one thing, they are usually inconspicuous, and are not easy objects of study. The distribution of many forms is of very limited extent, and their life-histories and habits, adapted, as they must be, to the life-histories and habits of hosts often of widely differing characters, show an extraordinary variety of detail. In some cases the egg is laid on the outside of the body of the host, and the embryonic larval stages are passed through in that position, in other cases the egg may be laid on the outside of the body of the host, while the

larva, after hatching, enters the body of the host to complete its development; in yet other cases the egg itself may be placed inside the body of the host, the larval stages being likewise passed in the tissues of that unfortunate insect. In some cases pupation may take place within the host, in other cases the insect will emerge to pupate, and when we add to these observations the fact that the host may be parasitised in different stages, we can perhaps form some idea of the enormously varied conditions under which the life-history must be gone through, and the great number of modifications which may be thuswise produced.

The first family of the series *Parasitica* is the *Cynipidae*, or gall-flies. These are very minute dark-coloured insects, and can be arranged in three groups, according to their habits.

The true gall-flies lay their eggs in the tissues of growing plants, in which the larva lives and feeds, generally, though not always, producing a gall.

Another group contains insects which do not themselves produce galls, but which lay their eggs in a gall which has already been produced by some other insect, their larvae thus obtaining the benefit, whatever it may be, which is to be derived from living inside a gall.

The third group comprises forms which, like the true ichneumon flies, are parasitic on other insects.

Another family of some economic importance is the family *Chalcidae*. These are, again, small insects, though some of them attain almost to the size of a small house-fly. They can be recognised, with a lens, by the fact that the antennae are elbowed, while the wings are almost devoid of ribs, or "nerves", with the exception of a stout nerve lying close to the anterior border of the wing. In some forms the thighs of the hind legs are tremendously thickened. They are insects having a compact and sturdy appearance, with a large, well-developed head, and are mostly parasitic on the eggs, larvae, and pupae of other insects. One large black chalcid has been found to be parasitic on the 'gelatine grub' of tea (*Belippa lohor*) in the Jorhat district of Assam. Its life-history is at present unknown, but it emerges from a neat round

hole towards the posterior part of the back of the grub as the perfect insect, pupation apparently taking place within the body of the larva. From the high percentage of gelatine grubs which are found to be parasitised when collected and reared in the laboratory, it is probable that this insect is in no small part responsible for the paucity in numbers of the gelatine grub in that district. Some Chalcids are plant parasites, and these include an exceedingly interesting group known as the fig insects. These insects live in the fruit of figs, and are remarkable in having wingless males, bearing little or no resemblance to the normal winged females, in some species. In other species there may be both winged and wingless males. One species is of immense interest as being concerned in a peculiar custom practised by cultivators of figs. They have supposed, from time immemorial, that the proximity of the wild fig tree is essential to the ripening of the fruit of the cultivated fig, and it is a practice, at certain seasons, to hang branches of wild figs amongst the branches of the cultivated trees. This practice is known as "caprification." The young fig is a sort of hollow fleshy receptacle, with very numerous and minute flowers at the base, and in the case of the wild variety is usually full of tiny chalcid fig-insects. These insects, however, cannot attain maturity in the cultivated fig owing to the unsuitable structure of the flower and, therefore, do not breed there. They are, on the other hand, supposed by many to be necessary for the perfect development of the fruit, and the custom of caprification is, therefore, explained as follows. The introduction of the wild figs brings numbers of fig-insects. The winged females emerge, and, entering a cultivated fig, endeavour to lay eggs in the flowers inside the fleshy cup. The irritation produced by their attempts results in some kind of stimulation which brings about the ripening of the fruit. In the absence of this stimulation the fruit does not ripen.

The next important family of the series *Parasitica* is that of the *Ichneumonidae*, or Ichneumon-flies. They are small insects with rather long slender antennae composed of many joints. The two pairs of wings have a more complex system of nerves, the two hind pairs of legs are placed close together on the body, and the

female is usually provided with a conspicuous slender ovipositor. They are parasitic, in most cases on caterpillars, and are of great economic importance for this reason. One member of this family has been found to attack the Red Slug Caterpillar of tea. The female lays her eggs beneath the skin of the caterpillar, and these eggs hatch into legless grubs which feed on the tissues of the host. Eventually they become full grown, and then emerge from the body of the caterpiller, and spin small white cocoons, inside which they pupate. It is not uncommon to see a dead caterpillar, on a leaf towards the lower part of a bush, surrounded and covered by the white, silky cigar-shaped cocoons of the ichneumons which have killed it. Ichneumon flies are also known to parasitise spiders, and certain interesting forms are known, which are parasitic on the wood-wasps described earlier in this article. The female in these forms is provided with an exceedingly long ovipositor which, at its extremity, is provided with saw-like modifications. The eggs are laid in the burrows of the wood-wasps, but in order to do this the ichneumon must first bore through the wood of the tree in which the wood-wasp grub is tunnelling. Sometimes she gets the ovipositor in, and cannot get it out, and she is then held until she dies. More often, however, the operation is successfully carried out, but even then all may not go well with the young grub. When it first hatches it is active, and wanders along the tunnel in search of the larva of a wood-wasp. Having found one, it clings to it, and begins to feed on it, living on the grub as an external parasite. Should the host attacked be small, it may not supply sufficient food for the ichneumon larva to become full grown, and the latter then dies, for it has been found that even if another host grub be offered to it, it will not touch it. In some cases also, when the host grub has been sufficiently large to enable the ichneumon larva to become full-grown, the parasite may have been carried by its host so far into the heart of the tree that it is unable to make its exit, in which case it dies a lingering death in the heart of the tree.

The so-called supplementary Ichneumon-flies, *or Braconidae*, form the last family of the *Parasitica* we shall deal with. They are similar in general appearance to ichneumon-flies, but are often

brightly coloured, and the abdomen is less mobile than in the ichneumons. Beyond the fact that they are parasitic, very little is known of the life-history of these insects. They usually attack caterpillars, but are also known to attack pupae, and sometimes also even perfect insects. Braconids have been reared, in this laboratory from several caterpillar pests of green manure plants, and many forms are known to parasitise important insect pests in other parts of India.

The second series of the sub-order *Petiolata* is known as the *Tubulifera*, on account of the terminal segments of the abdomen being modified to form a retractile tube which encloses the ovipositor. The insects of this series, which is very small in numbers compared with the other two, are popularly known as cuckoo-wasps, and are easily recognised by their bright metallic colouring and by the extremely hard and densely-punctured texture of the body. They are small insects, and with rather small wings for their size. The head is distinct and moderately large, with large eyes, and antennae which are sharply elbowed at the base, and the joints of which are often very indistinctly marked. The back of the abdomen is very strongly arched, and the underside concave, so that it appears as if sunk in. This modification appears to be connected with the habit of the insect of rolling itself up into a compact ball. The ruby-wasps are parasitic on the true wasps, the eggs being laid in the nest of the wasp alongside the grub, the larva feeding on the grub, and forming its cocoon inside the nest. They are often to be seen in bungalows and houses in search of nests of the common mud-wasps, which build in such localities.

BORBHETTA.

In a recently published Hand-Book of the Department, there is a note about the grant of land at Borbhetta, on which field experiments are being made by the Scientific Department in extension of similar work which is being carried out at the Tocklai Experimental Station. It may be of interest at this juncture to describe this piece of land and the work that has been begun there up to the present, as it is hoped that the experiments will eventually be of great interest and of considerable value to the tea industry.

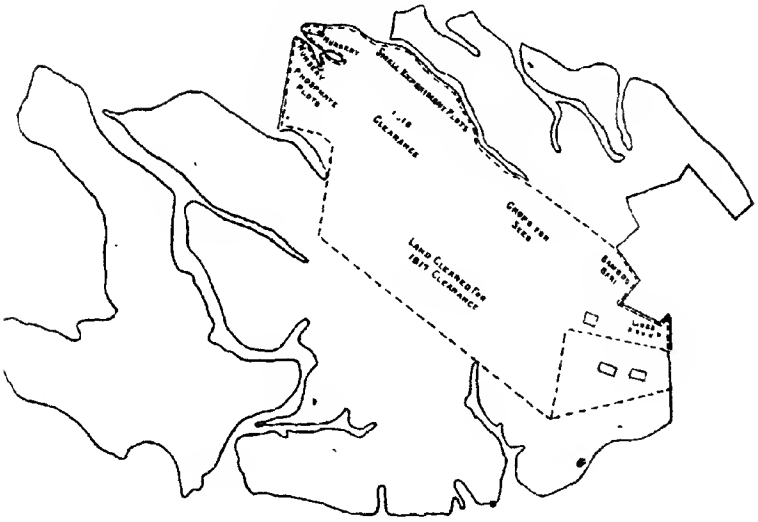
Borbhetta is situated at a distance of about two miles from Tocklai on land adjoining the Government Farm near Jorehat. The area is about 140 acres. Most of this land has been public grazing ground for many years. Parts consist of light timbered and scrub jungle. Among the plants growing there *Melastoma malabathricum* is conspicuous. *Andropogon aciculatus*, known as Bonguti in Assam, is the commonest grass. *Eleocharis sp.* is also common.

The land is situated fairly high, with a very slight slope downwards from south to north. It is interseeted by numerous hullahs which are a few feet below the general level. These have until recently been increased in size artificially by being cultivated for rice growing, and in some cases these operations have interfered with the ease with which the land can be drained. Most of the remaining land is fairly level, but much of it is broken up by numerous termite mounds and deep holes, and is of the type known as Korkhani.*. The soil is of the reddish grey old alluvium of the Assam Valley with usually a stiff, yellow sub-soil, often mottled with grey and red. When this is first brought to the

* Korkhani is the name given in Assam to ground which, when cleared of heavy forest or scrub jungle, as the case may be, is found to be intensely rough from the presence, usually at quite short intervals apart, of deep irregular holes and steep humps. The origin of this formation is unknown.

INDIAN TEA ASSOCIATION
BORBHETTA STATION 1917.

FULL LINES SHOW BOUNDARIES OF GRANT.
DOTTED LINES SHOW BOUNDARIES OF AREA NOW ENCLOSED



surface it has a toxic effect on vegetation. The following analyses made in this laboratory indicate the composition of the surface and sub-soil at Borbhetta.

ANALYSIS.

	Top soil.	Bottom soil.
Hygroscopic Moisture	5·58	1·20
(CALCULATED ON DRY SOIL.)		
Loss on ignition	2·89	2·17
Insoluble silicious matter	92·71	92·52
Total nitrogen	0·08	0·07
Total phosphoric acid	0·05	0·05
Total magnesia	0·12	0·15
Total potash	0·20	0·14
Total lime	0·04	0·03
Available potash	0·016	0·015
Available phosphoric acid	0·005	0·004
Soluble in dilute acid	1·41	0·19
Coarse sand	4·46	3·93
Fine sand	57·19	56 22
Silt	17·22	15·79
Fine silt	9·95	12·81
Clay	6·42	8·61

These analyses show the soil to be composed chiefly of fine sand and silt, and to be very poor in respect of organic matter, nitrogen, and total and available phosphoric acid. The sub-soil is however very variable in mechanical texture a few feet below the surface.*

We are fortunate in being able to apply to this piece of land the set of observations in their entirety, made within recent years by Mr. A. A. Meggitt, Agricultural Chemist to the Government of Assam, regarding the soil of the Government Farm, which is situated alongside it. Mr. Meggitt's observations are of much

* On attempting to make a well it was found at one place that a very coarse sandy soil, containing 77% of coarse sand and 19% of fine sand, occurred 8 feet below the surface, and this made it necessary to dig the well elsewhere. Another attempt was made not 20 yds. away, at a place where there was a slight hump in the land, and here a stiff sub-soil permitted of a satisfactory well being made.

interest, and are likely to have later on an important bearing on the results of our field experiments, and for this reason this opportunity is taken of quoting him in full.

"The soil of the high land is a reddish sandy loam of the old alluvium, lying on a hard yellow sub-soil, when the conditions have not been improved by cultivation, the soil is extremely shallow, varying from only 3 to 6 inches in depth.

REPORT ON ANALYSIS OF JOREHAT FARM SOIL.

	Surface Soil.	Sub-soil.
	Laboratory No. 5.	Laboratory No. 5 (*a*).
1	2	3
	Per cent.	Per cent.
Soluble in Hydrochloric acid with 12 hours digestion at 100° C.—		
Phosphoric acid (P_2O_5) ...	0·025	0·020
Potash (K_2O)	0·115	0·135
Lime (C_aO)	0·154	0·144
Magnesia (M_gO)	0·166	0·148
Soluble in 1 per cent. citric acid with 7 days digestion—		
Phosphoric acid	0·008	0·008
Potash	0·007	0·011
Loss on ignition (organic matter and combined water) ...	3·26	1·84
Nitrogen	0·114	0 051
Calcium carbonate ...	0·048	0·018
Reaction	Acid	Acid.

PHYSICAL CONSTANTS.

	Hygroscopic capacity.	Maximum water-saturation capacity.		Minimum water-saturation capacity.		Moisture in dry soil.
		Per cent. of water in saturated soil by weight.	Per cent. of water in saturated soil by volume.	Per cent. of water by weight.	Per cent. of water by volume.	
1	2	3	4	5	6	7
Surface soil	3·10	31·9	50·5	11·2	13·9	1·3
Sub-soil ...	...	30·0	50·0	7·2	9·1	00·19

These analyses agree quite well generally with some others made some years ago by the Imperial Agricultural Chemist.

These samples are acid in reaction, and the total lime present in all combinations, as well as the carbonate of lime, is quite deficient in quantity.

Carbonate of lime has an enormous influence on a soil's welfare chemically, physically, and bacteriologically.

Its effect on soil biological processes are in the right direction, and very great ; it also influences the texture of soils in a remarkable way, and is active in bringing into use the reserves of dormant plant food. Its presence in fair amount also ensures the most economical effect of any manuring given. Its absence forbids the use, for most cropping, of certain kinds of manures, unless it be first resorted to.

Any upland soil containing such small amounts of total lime and lime carbonate as are here present will most certainly respond markedly in the case of most cropping to applications of lime.

The amount of organic matter is probably greater than obtains in many Indian soils, but there is no doubt that a light soil of this character will be much improved in many ways by an increase in the amount of humus.

A good deal of the organic matter present is of a doubtful character and consists very probably of very old residues of little value; it is the presence and active decay of comparatively recent additions of organic matter which puts life into a soil.

The percentage of nitrogen present in the surface soil is what would normally be considered a fair one, but in view of the absence in anything like adequate quantity not as favourable as they mightbe by a long way, and an increase in the amount of nitrogen is indicated as desirable.

Of potash there is no dearth, and there would seem to be no immediate need for potash manuring.

Regarding phosphoric acid, these samples show a deficiency both in total as well as available supplies. There is thus a "real" as opposed to a mere temporary lack in respect of the element of plant food.

This lack of phosphoric acid is further aggravated by the absence of sufficiently large amounts of lime carbonate and humus, high percentages of which may, and often do offset a smaller percentage of phosphoric acid.

An acid condition of soil, besides being harmful in itself very often brings about a more rapid depletion of the soil's stock of phosphoric acid, in consequence of which most soils of a decidedly acid character are found to be lacking in this element, and to respond to its suitable application.

Turning to the physical constants, the hygroscopic capacity is low, and about what one would expect for this class of soil. It means that only water which is in excess of about 3 per cent. is available for crops, and plants are able to reduce the soil moisture content to somewhere about this figure before they begin to wilt. The top 6 inches of soil even during the cold weather normally contains a good deal more moisture than per cent. when under a close standing crop, so that usually there is sufficient water for the crop's requirements.

As regards maximum saturation capacity, these soils agree quite well with quoted figures for similar soils in Europe, and suggest that the optimum proportion of water for the growth of the plant is about 13·16 per cent. A recent determination of soil moisture in the surface 6 inches of the soil of this farm in August some few hours after rain gave 17 per cent. water. Soil moisture conditions are therefore probably extremely favourable for growth during the rainy season.

The figures for minimum saturation capacity are much lower than those cited (Hall, The Soil, page 69) for similar soils in Europe, and this probably due to the lower content of humus which obtains in our soils. This is an extremely important figure in gauging a soil's power to retain a reserve of moisture for crops during dry periods.

The sub-soil is worse in this respect than the surface layer, suggesting that the incorporation of organic matter, if it can be buried sufficiently deep, will have a great ameliorating effect indeed.

The sub-soil is capable of very great improvement indeed as the figures show, but it would probably be immediately disastrous to work it so deeply as to bring any considerable amount to the surface at once.

The growth of deep-rooting legumes as green crops will assist materially, but if the sub-soil could be stirred occasionally, while at the same time the surface cultivation is gradually deepened so that green crops may be more deeply buried, a greater depth of surface soil will result, which on this farm is very much to be desired.

I am convinced that for the cane cultivation, until the surface soil has been deepened and the amount of humus increased, it is of little use attempting manurial experiments on cane with artificial manures. No amount or combination of the latter can ever make up in the case

of a crop like sugarcane for loss of fertility due to shallow cultivation and lack of humus."

As the above observations of Mr. Meggitt were published before 1915, in which year work at Borbhetta began, we were at that time already in possession of most useful information in connection with the character of the soil.

Early in 1915 the first piece of land was cleared, and this was a piece adjoining the boundary between our land and that of the Government farm, and happened to be fairly level and free from korkhani holes. The second piece of land to be cleared was about 10 acres in extent and was situated immediately to the east of the first piece. This was all the clearing that was arranged to be done that year as we purposely wished to feel our way and extend operations slowly at first.

The first experiments made on the land first cleared have already been described in full in the fourth issue of the Quarterly Journal of 1915 under the heading "Experiments with phosphatic manures on green crops." The object of these experiments was to determine whether phosphatic manures would be of use on this class of soil for increasing the growth, in six or seven weeks time, of such low growing green crops as are ordinarily employed on tea estates. The actual sowing of the green crops took place in July and the plots had been manured previously with 8 lbs. each of crushed lime-stone a quantity of lime which was an eighth only of that sufficient to neutralise the acidity of the soil as determined by Mr. Meggitt. The plots were arranged in series of six, all but one of which were manured with sulphate of ammonia and sulphate of potash in quantities sufficient to supply 20 lbs. of nitrogen and 56 lbs. of potash per acre respectively. Four out of the six plots were manured each with one or other of the following manures —Basic slag: Superphosphate: Ephos Basic Phosphate: and Degelatinised Bones, each application supplying phosphoric acid at the rate of 112 lbs. per acre. These experiments will be referred to again in describing the work during 1916 and 1917.

In the winter of 1915, nurseries of Singlo and Matelli tea seed were established, with the intention of planting out a clearance from

them in 1916. The land for this clearance required considerable levelling. This had been done earlier in the year and a crop of Boga medeloa had been grown on it. These nurseries were not at all successful. The very acid nature of the soil*, rather unfortunate weather, and very serious attacks of crickets, accounted for a large percentage of deaths. It was observed however that such seedlings as were subjected to, but survived the attacks of crickets, formed the best plants in the nursery.

In 1916 the experiments with phosphatic manures were continued; no fresh manures were applied but the green crops were sown again, and the results, which have been described in the third issue of the Quarterly Journal for 1916 in an article entitled "The residual effect of phosphatic manures on green crops in the year following that of application," demonstrated that the phosphatic manures used had a very distinct residual effect in the second year, amounting in the case of superphosphate, which was the most effective, to 43 per cent. increase over the check plot, and the order of value of the manures shown in this first year was maintained.

The Borbhetta soil is everywhere exceedingly patchy in character. The reasons for this are probably partially to be found in connection with the variations noticed above in the mechanical nature of the sub-soil, which would produce local differences in the drainage, etc. and eventually in the nature of the surface soil, and are partially due also to the Korkhani nature of the ground and to the local action of termites. It was noticeable in these experiments that slight differences in the level of the ground and nature of the soil were responsible for great differences in the rate of growth of the green crops, and this fact has been brought prominently to notice this year, for, owing to the weather being dry at the time of year when green crops were being grown, the moisture, on which crop is so largely dependant, was less deficient in the hollows, and the green crops have grown best in these hollows. Also last year and this year no manures were applied to these plots and the differences in the quality of the soil from

* See Meggitt, Studies of an acid soil in Assam. Memoirs of the Department of Agriculture in India.

place to place on the area have been more noticeable than in the years when the applications of manures were made. For further details with regard to these experiments readers are referred to the article above quoted. Suffice it to say that the remarkable effects of phosphatic manures on these soils confirm Mr. Meggitt's observations and suggests that phosphatic manures may be of particular value on this class of soil when it is first brought under cultivation and has previously not been drained.

Last year also another series of experiments was instituted in order to find out the effect of various nitrogenous manures on the fertility of the Borbhetta soil, when used in conjunction with and without lime and with phosphatic manures. For this purpose it was necessary to choose a non-leguminous plant and joar was the plant chosen. The seed germinated very unevenly and for that reason it was impossible to obtain crops the weights of which would accurately indicate the effect of the manures, and no figures were therefore published, yet the relative effect of the different manures was very evident to the eye in the growth of such plants as thrived. The following plots 6 square rulls in extent were arranged, and half of each plot was limed at the rate of 25 maunds of crushed limestone per acre, the nitrogenous and phosphatic manures used being applied over the whole of the plot. The nitrogenous and phosphatic manures were applied at the rate of 40 lbs. per acre.

The great necessity for lime on this soil was demonstrated at once by the complete absence of anything but the most meagre growth on the unlimed halves of the plots. The next most noticeable fact was that where phosphatic manures were applied these could to some extent produce an effect similar to that of lime, that is to say, there was a little growth on the unlimed halves of plots where phosphatic manures were used, but none whatever on the unlimed half of plots which received no phosphatic and only acid or neutral nitrogenous manures. The effect of nitrogen was very marked on this soil, but unless lime or phosphate was applied there was no effect at all. In the case of nitrogenous manures which were alkaline in character, such as nitrolim, nitrate of soda, and nitrate of potash, small crops were

produced. As an instance of the effect of these manures a very good crop was produced on the limed half of the plot which received basic slag and nitrate of soda, or basic slag and oilcake, whereas hardly any crop at all was produced on the limed half of the plot which received only nitrate of soda, and a poor crop only on the unlimed half of the plot which received nitrate of soda and basic slag. Potash seemed to have some small effect also in reducing the toxicity and enabling the nitrogen applied to become effective.

Last year also a number of green crops plants were sown on areas sufficient to supply enough seed for us to distribute in small quantities to planters. Among the plants grown in this way were *Indigofera arrecta*, *Indigofera dosua*, *Leucaena glauca*, *Clitoria cajanifolia*, and several species of *Desmodium*. *Indigofera dosua*, which had not previously been tried in the plains, grew remarkably well, and so did *Desmodium polycarpum*, though the other green crops grew but indifferently, except where they were manured.

In the late autumn of 1916, nurseries of Singlo and Matelli tea seed were again established in order to enable us this year to complete the planting out of the 1916 clearance. The experience derived from the difficulty of establishing nurseries the year previously was of use, but in spite of all precautions the nurseries are poor. Matelli seed grew particularly well to start with, but has been very much damaged by crickets. These insects are more than an ordinary scourge on this piece of land. The Singlo nurseries were still more disappointing, but this must be put down partly to the inherent delicacy of the plant when grown away from the few situations which suit it really well.

The second piece of land cleared at Borbhetta in 1915 was partially planted with tea. As the result of the partial failure of the nurseries of 1915-16 above alluded to, it was not possible to plant all the area cleared nor to select suitably vigorous plants. After planting out however in November 1916 the clearance, though suffering severely in the cold weather, withstood the adverse conditions better than was expected and there is now every chance of

a successful clearance being established. The planting is 5 × 5 triangular. The clearance is drained on each side and has been drained between every ten lines of bushes. These drains are 3 feet deep and have vertical sides and their edges have been bunded.

In 1917 cowpeas were sown on all the phosphate plots referred to above immediately after the quotation of Meggitt's report on this soil. They will shortly be weighed. So far it is noticeable that there is still some residual effect from the phosphatic manures, though the discrepancies referred to in describing last year's results of these experiments are most noticeable this year, in consequence partly of the weather having been dry for most of the period of the growth of the crops.

The experiment with nitrogenous manures, using joar as a crop, are being continued this year. Joar has again been sown on last year's plots but no manures have been applied. Consequently the growth on the plots this year represents the residual effect of the past year's manurial applications. The effect of lime is still noticeable, and there is again hardly any growth where lime has not been applied. Phosphates too, are showing up well, but it is as yet too early to record the result of the year's growth in full. The same series exactly has also been begun on a similar set of plots alongside these, so that this year also, the effect in the first year of the manures tried will be observed. Two other sets of small experiments are being arranged this year to demonstrate the value of other and less tried nitrogenous and phosphatic manures.

The experiments made by Meggitt and ourselves having indicated that lime is essential on this soil for many crops and valuable for most, and that phosphates are also of great value in rendering nitrogenous manures available, it was decided to manure the clearance this year with lime and crushed bones. This was done. 15 mds. per acre of slaked lime was applied broadcasted and 2 oz. of crushed bones were forked in round each bush.

The clearance has been sprayed with lime sulphur and also with water glass to remove red spider, and is now looking well It is hoped that the remaining area of this clearance will shortly be planted.

Early this year about 17 more acres of land were cleared, to the south and south-east of the present clearance, and it is intended that this shall be planted up next year. The sketch map indicates the position of this land.

There are three insects which one would expect to give trouble on such a piece of land as that at Borbhetta—fine sandy soil, light, yet at the same time comparatively easily compacted, uncultivated, and grazed by cattle for years, with no heavy timber but merely light scrub jungle—for sometime after opening it out. They are, crickets, and surface grasshoppers, and red spider. They are all there, the latter doubtless much more numerous than it would otherwise have been, owing to cattle manuring. The presence of khetted hullahs, and of the Government Farm, means that we run the risk of invasion by caterpillar and other pests which will attack the green crops. This has already happened to a small extent. Also, since most caterpillar pests of tea will also live on in futuka jungle (*Melastoma*) we might anticipate a little trouble from some of those also.

This may be an opportune place and time to explain that the clearances at Borbhetta cannot be used for experimental purposes until after several years. In order to enable us to obtain accurate results from field experiments with tea, it is necessary to make these young plants into bushes, which will require at least three years, and then to divide the clearance into plots and measure the yield of leaf from these plots for at least two seasons before any difference in treatment is accorded to the individual plots. When that time comes we shall have a sound knowledge of the leaf bearing capacities of the individual plots, and shall then have a means of knowing whether the yield of the control plots accurately represent the yield which the other plots would give if they were treated in the same way.

G. D. H.

A PRELIMINARY NOTE ON A RECENT EXPERIMENT ON THE PRUNING OF TEA SEED TREES.

In the cold weather 1915-16 some experiments were commenced on the pruning of seed tea on the Rangajan T. E. Jorhat Tea Co. There are some acres of old trees and some newly planted. The old trees were quite healthy and yielding fairly well but they had grown much too tall, having long barren stems bearing all the fresh growth on their tops. Most of the plants had a number of branches which had become very congested in the centres. It was therefore decided to remove the centres from all the plants. An acre was then pruned 6 or 7 ft. from the ground. The branches on some of the trees were then spread out by inserting bamboos between them. In the rainy season 1916 the succulent shoots which were growing too high were pinched back and some attempt made to keep the branches from becoming too congested by nipping out superfluous ones at the same time. The pruned trees have flowered this season and the seed is undoubtedly better in quality and quantity than that from unpruned plants. It is too early to say whether 6 or 7 feet is the best height to prune. The writer is inclined to think that 3 or 4 feet would be better although it would lead to the production of more vegetative growth and it may be necessary to wait longer for the trees to produce seed again. The spreading of the branches by bamboos was a failure: the bamboo spreaders damaged the bark and did very little good. The shape of the trees can only be satisfactorily made by judicious pruning. The pinching back of the succulent shoots is very important as by that means the shape tree can be formed with the least shock. It is very important however that it be done in the late rains. If it is done too early, the plant begins to flush; if too late, too much succulent growth is produced in the early part of the next season.

The young tea was treated in various ways including pruning at different heights and the spreading out of branches by bamboo

frames. It seems however that the only satisfactory way is to let the young plants grow up until their stems are fairly thick (say one inch in diameter) and then prune to a few inches above the ground. If as soon as the shoots are hard enough to stand bending a good sized brick is fixed in the centre of the young bush the stems will not be able to grow up close together and a satisfactorily shaped tree is obtained without further heavy pruning. The shoots should be pinched back in the late rains and only those required to produce seed retained.

This note is only a preliminary one and further details will be published when the experiment is more advanced.

A. C. T.

FUNGUS BLIGHTS OF TEA IN NORTH-EAST INDIA DURING THE SEASON 1916.

GENERAL.

1916 was not a bad year for fungus blights. The most interesting outbreak of fungus disease was that of Blister blight (*Exobasidium vexans*) in Mangaldai. Here the disease had been present in one garden for years and yet had not spread to the neighbouring gardens, one of which was in daily communication with the infected areas. It is significant that the garden on which the blight was harboured was at a higher elevation than the rest of the gardens in the district.

The reports sent in by the district chairmen were a little more useful than those of the year before. This year it is hoped that records will be kept regularly, observations being recorded at the time of observation. For this purpose a number of forms have been sent to the sub-district chairmen so that they can record their observations month by month. In last year's reports it was obvious that in many cases severe attacks of blight which had occurred at the beginning of the season had been forgotten. Planters could assist their chairmen by letting them know whenever an attack of blight occurs on their gardens.

LEAF DISEASES.

Blister Blight.

(*Exobasidium vexans*).

Darjeeling.—The disease was serious all over the district. It shows no signs of abating and active measures are urgently necessary. The Darjeeling Planters' Association are now seriously considering a blight treatment scheme on a large scale. Nothing much can be done until the planters combine against this blight.

Terai.—Very little blister appeared in this district.

Dooars.—The disease was confined to a few gardens at a higher elevation than the rest.

Assam.—A few gardens were severely attacked. It was very interesting to note that the disease was found throughout the cold weather on some gardens. It was reported in Mangaldai for the first time, but investigation showed that it had been present on one garden at a higher elevation for at least five years. Its first appearance coincided, strangely enough, with the return of the manager from a visit to a badly blighted garden in Darjeeling. Last year it spread to some of the other gardens in Mangaldai for the first time, but as energetic measures have been taken to eradicate it at once it is not likely to cause serious damage

Cachar and Sylhet.—The disease is unknown.

Copper Blight.

(*Laestadia camelliae*)

On a few gardens in Assam the disease was severe in April, May and June, and at the commencement of the cold weather.

It was not reported from other districts but was undoubtedly present.

Brown Blight and Die-Back.

(*Colletotrichum camelliae*, *Gleosporium sp.*, *Glomerella cingulata*).

This disease was specially severe on some gardens in Sibsagar and in Bishnath. It was most prevalent in the early rains.

It was not reported from other districts but the Mycologist observed it in Cachar and in Darjeeling.

Grey Blight.

(*Pestalozzia sp.*)

This fungus caused very little harm. It was present everywhere.

Rim Blight.

(*Alternaria sp.* and physiological causes.)

This disease was common in Doom Dooma and Bishnath but not very severe.

It was not so bad as in the previous year.

Canker.

There are three kinds of canker, caused by mechanical injuries, insects, and vegetable organisms, respectively. The last is comparatively rare. The fungus, a genus of the *Nectria*, generally associated with cankerous growths, rarely produces them on tea: Red rust sometimes produces swellings of the stems and roots: a condition which is common in Cachar and Sylhet.

The disease caused by *Nectria sp.* was common only in Darjeeling and the Terai, where, on a few gardens, it has caused very serious loss. The measures taken for its control have been successful.

Red Rust.

(*Cephaleurus virescens.*)

This fungus was common in all districts but was not reported by many so it was probably not severe anywhere.

Thread Blight.

(*Sterile mycelium.*)

The fungus was present in all Districts in damp shady places near jungle. Stick pruning has reduced the attacks of this disease to a minimum in many districts but the increase in the area left unpruned has led to a corresponding increase of thread blight even in Doom Dooma where the most careful pruning has been carried out for years.

Root Diseases.

There has been a decided reduction in the amount of root disease in all districts. *Hymenochaete noxia* and *Ustulina zonata* were the most common. *Thyradaria tarda* was still present on gardens in Dibrugarh and on the North Bank, but it was not so prevalent as in previous years. Rosellinia bothrina was found in Darjeeling.

COLD WEATHER SPRAYING EXPERIMENTS.

The following are the results of some comparative spraying experiments carried out last year on Cinnamara garden of the Jorehat Tea Co., Ld. Seven areas of approximately a hundred bushes were sprayed, after the bushes had been cut back heavily, with the following solutions :—

1. Carbonate of soda and lime strength given in pamphlet on spraying, *i. e.*

   Crystalline carbonate of soda (washing soda) 7 lbs.
   Quicklime ... ... 2 „
   Water... ... ... 10 gals.

2. Carbonate of soda and lime 1½ times as strong.
3. „ „ „ 2 „ „
4. „ „ „ 5 „ „
5. Nitrate of soda a 1 per cent. solution.
6. Carbonate of soda and lime strength given in pamphlet and nitrate of soda a 1 per cent. solution.
7. Carbonate of soda and lime strength ½ that given in pamphlet and nitrate of soda half strength.

In January 1917, the bushes were pruned to about 15 inches and in February 1917 bad wood was cut out of them. This was carefully collected and weighed at the Tocklai Experimental Station. The following figures show—

(1) the total weight of bad wood cut out from each area ;

(2) the number of bushes dealt with in this way on each plot, and (calculated therefrom).

(3) the average weight of bad wood per bush :—

TABLE I.

Plot No.	Weight of bad wood.	Total number of bushes.	Average weight of bad wood per bush in ounces.
1	15·75 lbs.	83	3·03
2	18·50 ,,	90	3·28
3	16·375 ,,	90	2·91
4	29·00 ,,	90	5·15
5	13·00 ,,	94	2·21
6	16·75 ,,	99	2·70
7	14·25 ,,	98	2·32

Measurements were also made of the circumference of the shoots of a number of the bushes in each plot in order to ascertain the average thickness of the new growth. The results are set out in the following table :—

TABLE II.

Plot No.	Number of shoots measured.	Average circumference in inches.	Minimum circumference in inches.	Minimum circumference in inches.
1	107	·95	1·80	·30
2	175	·95	2·05	·52
3	260	·97	1·82	·51
4	209	·93	1·57	·55
5	279	1·20	1·90	·45
6	181	1·26	2·20	·40
7	219	1·03	1·70	·45

It will be noted from Table I that plot No. 4 which was sprayed with Carbonate of Soda and Lime of five times the ordinary concentration was obviously damaged, as the increase in the amount of dead wood indicates. The difference between the figures for the other plots are probably well within the limits of experimental error, but it is noticeable that plot No. 5, which certainly was distinctly the best to the eye, yielded the smallest amount of bad

wood per bush. Reference to Table II shows that the average thickness of the stem was noticeably greater in the case of the three plots which were sprayed with Nitrate of Soda, and it also shows that the average circumference of the new shoots of the bushes which were damaged by treatment with the strongest solution of Carbonate of Soda and Lime, (*i. e.* plot No. 4) produced shoots with the smallest average circumference.

It would have been of interest to have had figures from a plot similar to the sprayed plots but untreated. This unfortunately was not arranged for when the experiment was initiated.

The deductions to be drawn from these experiments are that there is no object in using Carbonate of Soda and Lime in greater strength than that given in the pamphlet on Spraying and that Nitrate of Soda in 1 per cent. solution is of benefit in producing thickening of the new growth from cut back tea.

NOTE ON THE MANUFACTURE OF CHARCOAL.

In the last issue of this journal (pt. 1 of 1917) an article on the Manufacture of Charcoal, reprinted from the Journal of the Board of Agriculture, was prefaced by a note kindly furnished to the Department by a Forest Officer in Assam.

This information is now supplemented by the following note on the Manufacture of Charcoal in the hill forest of Darjeeling District, which came from the Director of the Kurseong Forest School in reply to a request for information.

Selection and preparation of wood.—All kinds of wood are burnt together and no attention is paid as to whether the wood is green or dry. Partly decayed and hollow logs are used—the hollows if large are filled up with small pieces of wood. Logs are seldom split up into small pieces. I have seen pieces as much as 8 ft. in girth and even larger used. Lengths vary as a rule from 2 to 10 ft. according to convenience of stacking. Large pieces are stacked at the bottom and small pieces on top. Where there is a large demand for firewood and extraction is cheap and easy—wood that can be easily split up is generally converted into firewood—the balance, *i. e.* large logs that are difficult to split, crooked and knotty pieces, etc., are converted into charcoal.

As a general rule hard woods yield better charcoal than soft woods—but this is not always the case. For example *Castanopsis hystrix* (Katus), a moderately hard wood, yields inferior charcoal.

The following woods yield the best charcoal for general purposes.

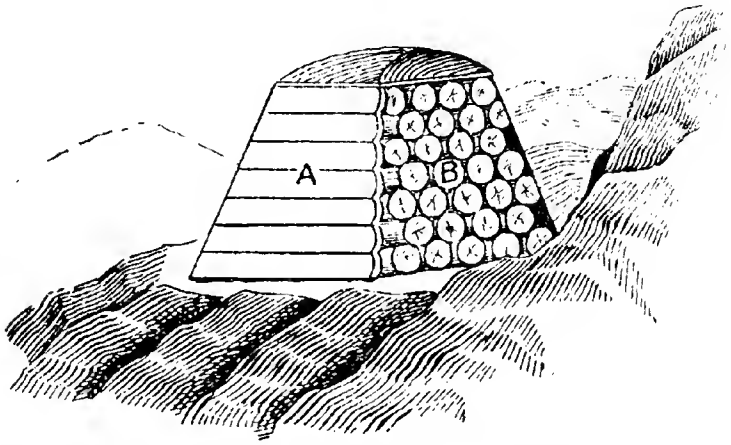
Plains and lower hills up to about 3,500 ft.		Hills above 3,500 ft.	
Sal	... *Shorea robusta.*	Buk	... *Quercus lamellosa.*
Khair	... *Acacia catechu.*	Phalat	... ,, *annulata.*
Siris	... *Albizzia Sp.*	Arkaula	... ,, *spicata.*
Sidha	... *Lagerstroemia parviflora.*	,,	... ,, *fenestrata.*
Pakasaj	... *Terminalia tomentosa.*	Sungre Katus	,, *pacaphylla.*
Kul	... *Zizyphus juguba.*	Pipli	... *Bucklandia populnea.*
Chalta	... *Dillenia indica.*	Jhingini	... *Eurya japonica.*
Satri	... ,, *pentagyna.*		
Sissoo	... *Dalbergia sissoo.*		
Guhilo	... *Calicarpa arborea.*		
Chilauni	... *Schima wallichii.*		
Saur	... *Betula cylindrostachys.*		

Site for the Kiln.—A depression is chosen because it is easier to carry wood down hill. Charcoal burners generally prefer

an old kiln site. When a new site is chosen the brushwood on the ground is seldom removed or burnt.

Construction of the Kiln.—Sizes vary from 6 to 8 ft. in height and from 10 to 20 ft. in diameter. The following drawing shows the method of stacking wood in a kiln.

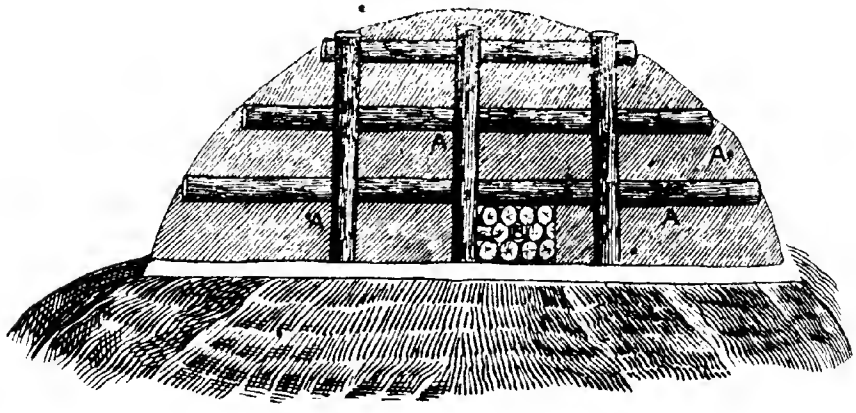
Side view of Kiln showing method of stacking.



In the part marked A in the above sketch the logs are arranged with the ends facing the slope. This is done to prevent the logs in part B rolling down hill.

The following drawing shows the kiln with cover on just before being set fire to. Notice opening in cover for setting kiln alight.

Kiln with cover on ready for firing.



A A = frame work of poles to hold up cover of kiln.

B = opening in cover to set the kiln alight ($2' \times 3'$) on side exposed to wind ; no flue is made.

Covering the kiln.—The inner cover consists of a layer of leaves, twigs, etc., the outer cover is made of earth dug up from near the kiln site. A covering of from 2″ to 3″ is considered sufficient, except on the top and on sides exposed to strong wind, where it is 4″ – 6″ thick.

A frame-work of poles is built up against the kiln to hold the cover up and also to let men get on to the top of the kiln.

Firing the kiln.—Dry chips of wood are heaped up in front of the opening and set fire to. It takes from 12 to 24 hours to set the wood in the kiln alight. When the wood in the kiln catches fire the opening is closed.

Regulating the burning.—Vent holes are made when the opening is closed. The first holes are made about $\frac{3}{4}$ way up.

More holes are made on the sheltered sides and less on the sides exposed to wind. If the wind is strong no holes are made on the windward side.

During the rains a bamboo mat cover is erected over the kiln.

Opening the kiln.—When carbonisation is completed all the vent holes are closed down. Whether the fire in the kiln is allowed to die down completely before it is opened depends on the demand for charcoal in the bazar and also to a certain extent on whether the charcoal burners are in need of advances from their sardars. In either of these cases the kiln is often opened before the fire dies down completely.

The hill men do not use water if they can help it as this spoils the charcoal. Water is used occasionally but earth is preferred to put out smouldering embers. Partly burnt logs are put on to the next kiln.

Yield of charcoal.—The yield varies from 12 to 15 per cent. of the weight of wood used.

Cost and financial return.—Wood for the manufacture of charcoal is paid for by contractors at the cubic foot rate. The contractors employ charcoal burners and pay them at fixed rates per bag of charcoal manufactured. The rate generally paid is about As. 8 per gunny bag.

NOTES.

The use of Charcoal in Agriculture.—Although the most noticeable feature of Indian Agriculture is the beneficial effect of water yet the fact is often overlooked that during the wet part of the year lack of aeration sets the limit to the productiveness of the soil. This matter was referred to recently by Mr. Howard who noted the good effect of introducing into the soil in the wet time of year anything which tends to retain air. Among the substances suggested was charcoal. An article on charcoal was reprinted in the last issue of this Journal from the Journal of the Board of Agriculture, Vol. XXI, No. 11, February 1915, and in this issue there is also a note on the same subject.

The subject came again before the officers of the Department in correspondence with the manager of a saw mill, who stated that he could obtain large quantities of charcoal and asked if any use could be made of it on tea estates.

Charcoal would undoubtedly have a beneficial effect on the heavier tea soils, though the quantity per acre which would be necessary to produce a noticeable effect would be considerable. However, where charcoal dust is available at low cost in the neighbourhood of estates, experiments might be instituted which would throw light on this problem. We suggest that charcoal at the rate of from 1 to 5 tons per acre might be hoed into a few square nulls of a clearance, and the subsequent treatment of the area be exactly the same as that of the rest of the tea. Within 2 or 3 seasons the beneficial effects of charcoal, if there are such, would be noticeable in the appearance of the tea and the root-growth.

We shall be pleased to give particulars as to the source of charcoal.

An article on the action of charcoal on soils appeared recently in the Journal of the Royal Horticultural Society, Vol. XL, Pt. 3, April 1915. It was suggested in this article that the action

of charcoal may be twofold. Firstly, in heavy soils and soils which are inclined to become water-logged in wet weather, charcoal retains air, which is given up slowly and is used by the roots of bushes at a time when the water-logged condition has made the soil deficient in oxygen. It is also suggested that certain soils described as "sick" are improved by the addition of charcoal which absorbs toxins. A certain experimenter extracted a sick soil with water, and after filtering the extract through charcoal found that this extract was a much better medium for plant growth than an extract of the same soil which had not been filtered through charcoal.

C. O. P.—1,200—31-7-1917.